CHAPTER 13: PACKINGS AND GASKETS

Packings and gaskets are elements used to "seal" or prevent the loss of fluids (liquids, gases, vapor, etc.) that are at a higher or lower pressure (vacuum) than that of the medium surrounding the product to be confined.

The materials used can be quite varied, taking into account the pressure they must withstand, the temperature, mechanical stress, chemical attack from the fluids, product contamination, etc.

For example, the packing for a pump for acid (e.g., sulfuric acid) is not the same as that for an alkali (e.g., soda ash), the pump shaft speed (300 rpm or 2800 rpm), etc.

A gasket in a steam pipe operating at 10 kg/cm² must withstand approximately 183°C (361°F), but if the steam were superheated to 340°C (644°F), the thermal conditions would be different, etc.

The installation and tightening of both gaskets and packings are also important.

A wide gasket, for the same tightening torque, compresses less than a narrow gasket (because the pressure is greater in the narrow gasket due to the smaller surface area: P = F/S).

A plate should be tightened in a crisscross pattern so that the force is evenly distributed to maintain the plate's parallelism.

A packing should be tightened considering the type of lubrication used: whether it is lubricated by the loss of the fluid itself (in the case of water, there should be a small loss that serves as lubrication and cooling, generally one to two drops per second) or whether there is an external lubricating and cooling fluid (which, in addition to preventing the loss of the fluid being sealed to the outside, can still allow some fluid to enter the sealed fluid).

Gaskets are currently being replaced by mechanical seals, and gaskets by "gasket formers" based on pastes or elements that tend to harden with temperature, oxygen in the air or lack thereof, or the mixture of two products (epoxy type).

Let's look at some of the most common problems and their solutions**:**
"Man entry" joints, "head entry" joints, "hand entry" joints:

For low pressures (less than 15 kg/cm²), they are generally made of braided asbestos (a type of asbestos that is silkier, with long, flexible fibers), like a folded cloth forming a ring, or already shaped to the elliptical or oval form of the gasket seat and sewn at the joint ("glued" with paste and graphite).

They come with flaked graphite on their outer surface to prevent sticking and improve sliding (lubrication) when tightened.

To order it, you must provide the diameter measurements of the ellipse (OVAL type gasket, the larger and smaller diameters).

Before removing the cover, it is advisable to "break the vacuum" (cool the boiler below 60ºC 140°F), ensuring that nothing falls inside the boiler (sometimes it is advisable to weld a ring or washer onto the covers to attach a safety wire or cable).

Remove the bridge and tap it with a mallet with a wooden block on one side of the cover (carefully!).

To install it, the gasket seat on the inlet cover and the gasket seat on the casing must be properly cleaned (by scraping and brushing well, but avoiding removing material from the seat or scratching it, as it will be damaged and lost; if the seat is in bad condition, it must be "filled" and properly resurfaced).

Once the seats are clean, the gasket is mounted on the lid and inserted into the boiler, tightened by hand with the bridge nuts (after brushing and lubricating the threads with graphite flakes using heavy oil, gear oil, or grease).

Then, alternately tighten the nuts mounted on washers with a long-handled wrench.

Once pressure builds up, the gasket must be retightened very carefully.

This is because the gasket weakens with the temperature and internal pressure of the boiler.

A manhole has a surface area of approximately 1000 cm² and a pressure of 10 kg/cm². This means a tightening force of 10 tons (10,000 kgf) is required when the boiler is pressurized.

When the boiler shuts down, this force is lost, and the pressure is instead pushed out by the vacuum created by the condensation of the steam, allowing the gasket to loosen and leak.

A gasket should never be left leaking, as this can affect the seal and the moisture from the leak will cause corrosion.

When the pressure exceeds 15 kg/cm² (213 PSI), the use of prefabricated gaskets with a backing material may be advisable.

Gaskets with inserts or mesh are suitable for boilers with pressures up to 21 kg/cm² (299 PSI). For higher pressures, spiral-wound gaskets or gaskets lined with copper or bronze, such as those used in automotive cylinder heads, are recommended.

These gaskets must also be carefully installed and retightened, following the supplier's instructions. The use of sealing compounds should be considered in some cases, and the use of graphite may not be advisable when the gasket could cause corrosion of the seat (in the case of spiral-wound stainless steel gaskets, galvanic corrosion occurs that "eats away" at the iron seat of the boiler and the lid).

Graphite or special greases are also used in these cases for the threads.

When it is necessary to perform high-pressure hydraulic tests (strength tests), the gaskets must be replaced after the test.

Sometimes it is advisable to use gaskets made of less expensive materials that can withstand the pressure (the temperature will be ambient) for the test, and then the correct gaskets will be installed.

Again, do not leave the gaskets in place for extended periods; the seats will become scratched, and the cover or the gasket seat will corrode.

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Graphite may not be advisable when the gasket could cause corrosion of the seat (as in the case of stainless steel spiral-wound gaskets, galvanic corrosion occurs, which corrodes the iron seat of the boiler and the iron of the lid).

Graphite or special greases are also used for the threads in these cases. When high-pressure hydraulic testing (strength testing) is required, **the gaskets must be replaced after the boiler's hydraulic test.**

Sometimes it is advisable to use gaskets made of less expensive, pressure-resistant materials for the hydraulic test (at ambient temperature), and then install the correct, high-quality gaskets.

It is reiterated, do not leave the gaskets with leaks; wasting a lot of time will "scratch" the seats and corrode the lid or the seat of the casing.

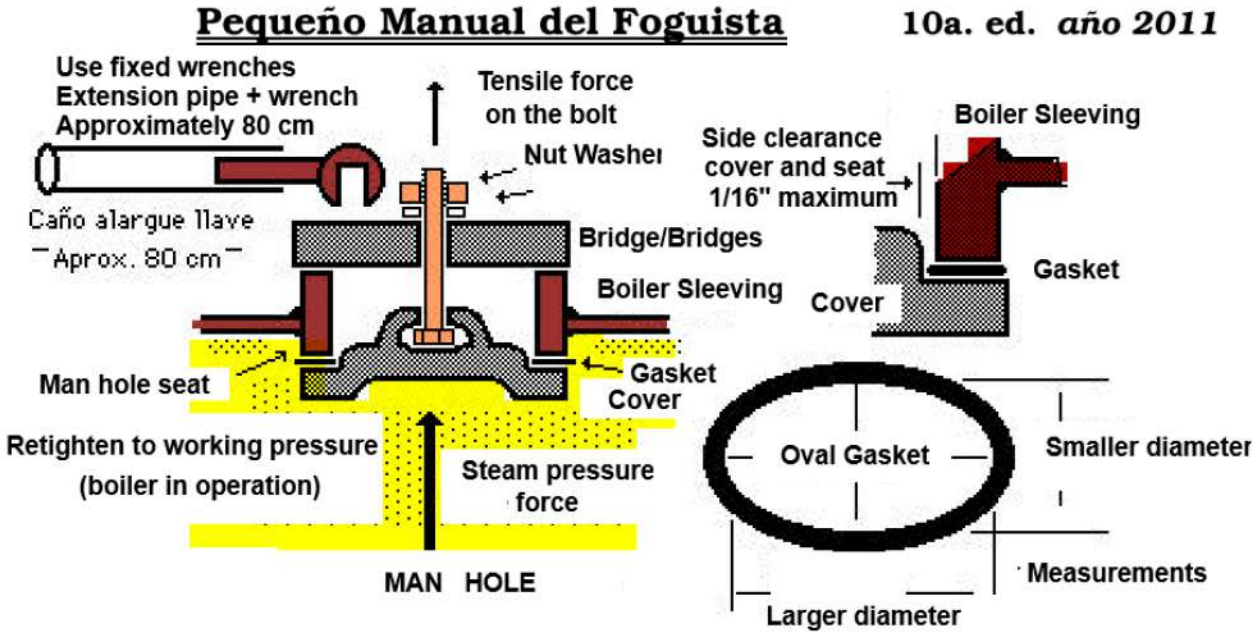


Plate Gaskets

In this case, the pressures for using flange or plate gaskets in the steam piping of the industrial plant must also be considered. At low pressures, gaskets generally need to be cut from sheets of varying thicknesses.

The appropriate gasket thickness is the thinnest that the seat finish allows (the more perfect the seat surface, the thinner the gasket can be and the better its seal).

As pressure and temperature increase, the gasket may contain higher-temperature materials and metal inserts that improve its pressure resistance (wire mesh, metal shavings, etc., up to preformed spiral-wound gaskets, used in high pressure and temperature applications).

The gasket must be cut correctly, so that it occupies the surface where the sealing area meets (by trying to make a gasket that is too large, the pressure of the screws is distributed and the sealing pressure on the gasket is poor, not tightening well and allowing leakage).

Thoroughly clean the surfaces to be sealed on the plate (including any grooves), and apply sealant and lubricant if necessary.

If the gasket is no longer graphite-coated, this can be prepared graphite flakes or another product purchased for this purpose. However, graphite should not be used when the gaskets are made of precious metal, nor with spiral wound gaskets under high pressure, as graphite can cause corrosion on the seat.

In this case, only the surfaces in contact with the gasket should be thoroughly cleaned.

Check the alignment of the valve seats. Clean and lubricate (graphite or other lubricant) the bolt threads. Tighten evenly and alternately as you would tighten the cylinder head of an automotive engine (the tightening torque will depend on the pressure plate, the appropriate quality of the bolts, which are generally rated according to the fluid pressure and specified by the plate).

The plates are standardized according to their intended use: pressure and temperature, pipe diameter, etc., generally by Series 150-300-600-900 or PN 10-16-25-40, etc., or the applicable standards.

The plates should not be retightened without first shutting off the fluid or steam they carry, taking great care not to overtighten the bolts, which will weaken them (a torque wrench can be used).

As an example, we can say that: a 1/2" bolt with 13 threads per inch has a maximum torque of 4 kg-m (kilograms per meter, meaning that on a 1-meter lever, a force of 4 kilograms translates to a tightening force of 1820 kgf per bolt); a 5/8" bolt with 10 threads/inch has a torque of 8 kg-m, etc. This torque depends on the quality of the bolts.

The finer the thread pitch, the greater the force for the same torque.

Tightening the nuts on the bolts of a flange/pipe plate joint under pressure can result in a serious accident if the bolts break.

As an emergency sealant, in case the surfaces are damaged, and which also works for threads, you can make the following: Boil linseed oil until it thickens to a cool, honey-like consistency. Take one measure of graphite flakes and one measure of red lead powder (adjusting the amount depending on the quantity used, as it hardens). Mix with the linseed oil until you reach a desired paste consistency. Apply to both sides of the joints and press firmly. (This paste will dry and seal, but can be removed when necessary.)

Do not confuse this with litharge (glycerin and litharge), which is widely used at low temperatures and as a sealant for various difficult-to-seal fluids, such as fuels, oils, coolants, etc.

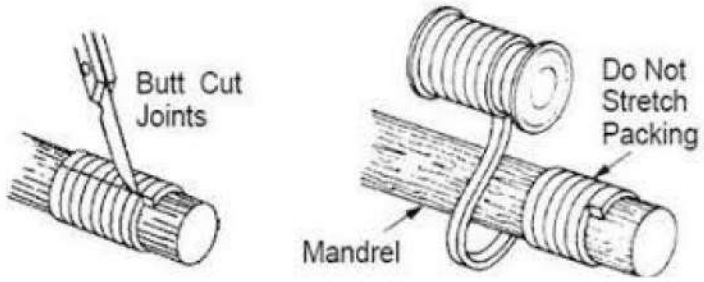
As a rule of thumb for the use of gaskets, a manufacturer has established that they can be used up to the numerical limit that comes from multiplying the pressure in PSI by the service temperature in degrees Fahrenheit (°F):

Material	Maximum Pressure x Temperature	Max. Temperature °F
Rubber	15,000	300
Vegetable Fibers	40,000	250
Solid Teflon	75,000	500
Rubbed Asbestos Cloth	125,000	400
Compressed Asbestos	250,000	850
Types of Metal	above 250,000	Tmax. (F) depends on metal

PACKINGS:

These are used to seal valve stems, pump shafts, etc. The material varies widely, with asbestos (now banned), Teflon, and graphite (synthetic) still commonly used. They can come as pastes, but are generally sold as cords or tape. The installation technique differs between pump shaft and valve packing.

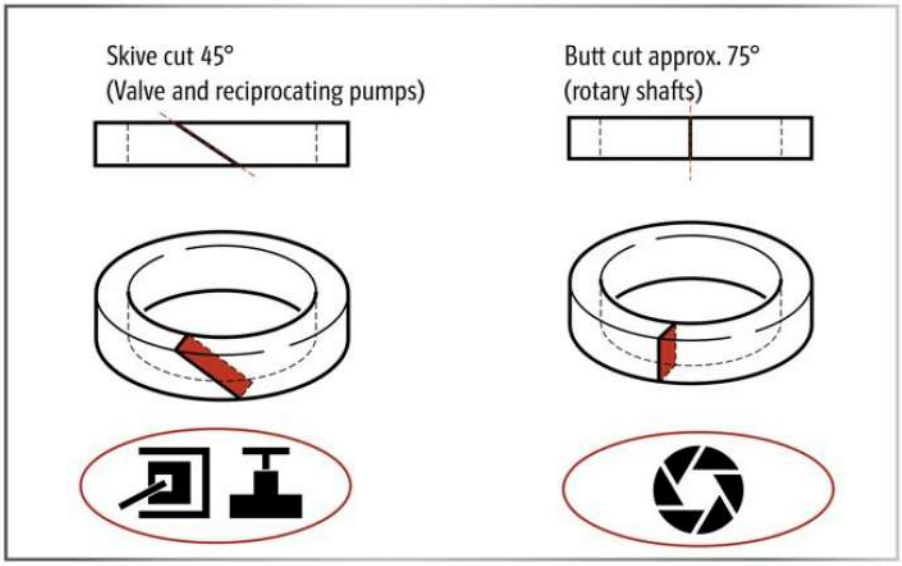
To cut the packing, depending on whether it's for a pump or a valve, you must take a piece of pipe or shaft with the same diameter as the pump shaft or valve stem.



(Packing stretch and cut, SOURCE: https://practicalmaintenance.net/)

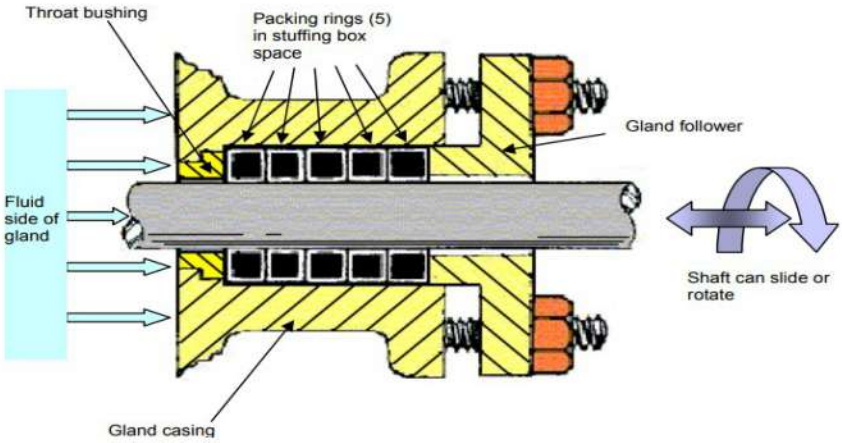
Let's wrap a few turns of the packing roll around the "shaft" and cut the packing with a very sharp knife.

For pumps, the cut will be straight (a longitudinal cut along the center of the shaft, so that when the packing gland is tightened, the packing compresses slightly against the shaft and housing, elastically, allowing the shaft to rotate and be lubricated by the fluid being sealed or the auxiliary lubricant.



(Packing cut 45° for axial movement, or straight for rotary shafts, SOURCE: https://www.propack.ag/)

This should lose one to two drops per second, preferably more at the beginning). For a valve, the cut will be at a 45° angle (a 45° cut relative to the shaft, so that when the packing gland is tightened, it tends to close around the shaft and housing, blocking the fluid passage).



(Packing rings and Gland, SOURCE: https://automationforum.co/)

When installing the gaskets, the cuts should be evenly spaced along the circumference (remove the old gasket completely using a corkscrew or a steel wire with a hook).

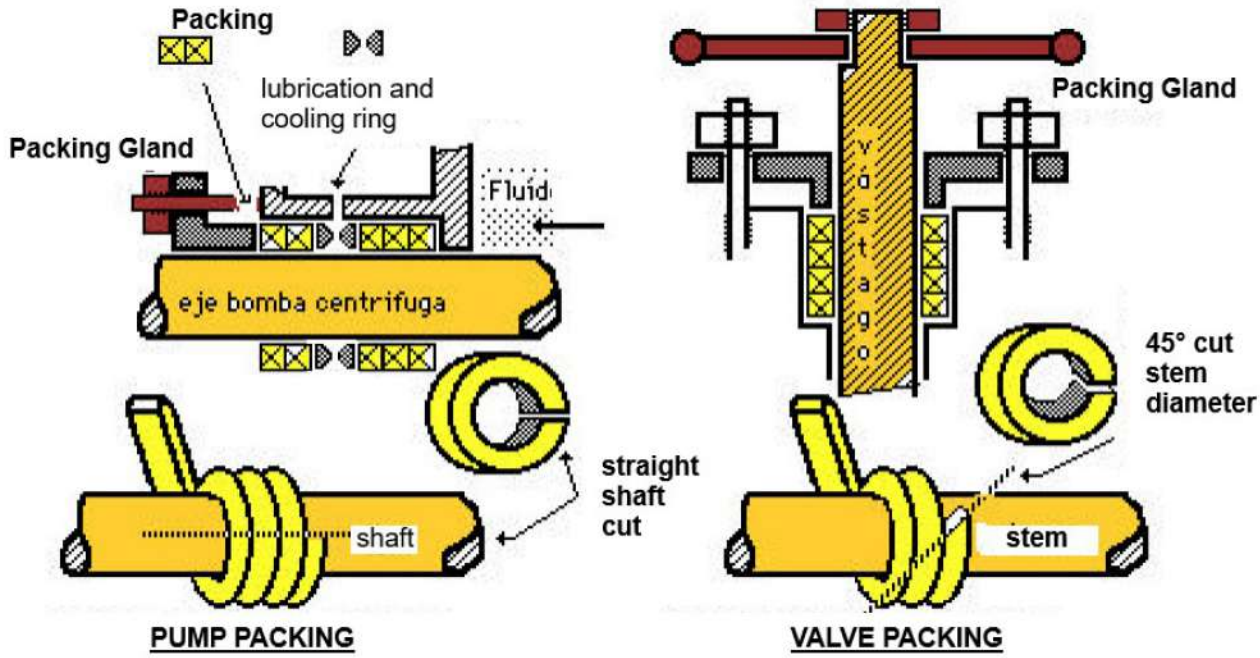
Do not overtighten the packing gland at first; it's better to let it leak a little more and tighten it gradually (tightening the nuts gradually and evenly).

As a general rule, never start a pump without the fluid to be pumped or without opening the seal and packing lubrication valve, since lack of lubrication will not only cause the packing to "burn" but can also damage the pump's internal wear rings.

Centrifugal pumps should also be started with the discharge valve closed when their power exceeds 10 HP; that is, start them without a load, but "flooded."

The valves on some equipment, such as refrigeration (ammonia) systems, should have their clamps loosened to maneuver the valve and then retightened once the valve is in position. This prevents leaks.

When a pump or valve seal starts leaking too quickly, it's time to repair either the pump shaft or the valve stem (which may be bent, misaligned, or scored).



In some cases, pumps have a wear sleeve that can be resurfaced or replaced. Otherwise, the shaft will need to be rebuilt (without warping it) and reground (in some cases, this can be done with cold-applied hard chrome plating followed by reground).

In other cases, a new shaft must be manufactured from the appropriate material (especially if corrosion is present).

Asbestos is a material whose fibers should be avoided, as inhaling them can cause cancerous lesions. Its use is being phased out for this reason. It is already banned in some countries, especially "blue" asbestos, which was widely used in thermal and acoustic insulation.

THREADED JOINTS:

Threaded joints in pipes (pipe threads generally have a taper that causes the "male" thread to tighten against the "female" thread) still require some type of sealant to prevent fluid loss between the threads.

This sealant will also depend on the temperature and the type of fluid (water, steam, naphtha, fuel oil, etc.).

Nowadays, materials such as Teflon tape and Teflon paste are used. Also very good are those prepared with: white lead or red lead powder with annealed linseed oil, litharge with glycerin, or, in cold water, a "filastic"

solution with slightly hardened paint remnants, etc.

Care should be taken not to use pastes containing flammable elements in oxygen pipes. Litharge with water or Teflon suitable for this application should be used instead.

There are other commercially prepared products; the manufacturer indicates the correct way to use them.

Litharge (yellowish): lead oxide PbO; White lead: basic lead carbonate used as a white pigment;

Minium (red): lead oxide Pb3O4...all these lead derivatives are poisonous.

Glycerin: obtained as a byproduct of oils and fats; do not use it in oxygen.

Stoker Boiler Handbook 2011, C.W.T. – CHAPTER 13: PACKINGS AND GASKETS

The Stoker Boiler Handbook ("Pequeño Manual del Foguista" in spanish) by C.W.T.
was written thanks to Apple Mcintosh computers series, first one the 128K owned by CWT in 1984